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(54) Title: ENDOSCOPIC SURGICAL INSTRUMENT		
(57) Abstract		
<p>An endoscopic surgical instrument (201) includes a housing (210), a single access conduit (212) formed in the housing (210), an irrigation port, and an evacuation port, each port being connected through independent valves to the single access conduit (212). The single access conduit (212) has a first end and a second end which is terminated in an aperture formed in the housing (210). A closure is provided for the aperture. A viewing device, such as an endoscope, is insertable through the aperture and the single access conduit (212), and is extended slightly beyond the first end. An electrode assembly (202) having two or more retractable RF electrodes spaced a predetermined distance and angle apart, is also insertable through the aperture and the single access conduit (212), and is extendable beyond the first end. Each RF electrode is in electrical communication with a means for supplying RF energy and for continuously measuring impedance across the electrodes.</p>		

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Specification  
**ENDOSCOPIC SURGICAL INSTRUMENT**

#### RELATED CASES

This application is a continuation-in-part of my co-pending U.S. Patent Application serial No. 08/025,003, filed March 2, 1993 which is a continuation-in-part of my co-pending U.S. Patent Application Serial No. 07/779,108 filed October 18, 1991.

## BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a surgical instrument and more particularly to an instrument with the capability for continuous irrigation and evacuation of fluid into and out from a body cavity of a patient during Laparoscopic or Endoscopic surgical procedures, and for the simultaneous measurement of tissue impedance and the ablation of tissue with fixed or retractable electrodes using R.F. energy.

### Brief Description of the Prior Art

Laparoscopic/endoscopic surgical procedure allows a surgeon to see inside the body cavity of a patient without the necessity of large incisions. This reduces the chances of infection and other complications related to large incisions. The endoscope further allows the surgeon to manipulate microsurgical instruments without impeding the surgeon's view of the area under consideration.

During these surgical procedures it is desirable for as few lines as possible to enter the body of the patient. This reduces the size of the incision the surgeon needs to make. It follows from this that the greater the number of functions provided by a single instrument or the greater the number of instruments able to be passed through a single line entering the patient's body, the better.

Furthermore, in certain procedures it may be desirable to irrigate the area under consideration. This in turn necessitates the evacuation of the irrigation fluid or,

1 when bleeding has occurred, the blood or smoke or tissue  
2 residue generated by the surgical procedure.

3 From what has been said above it should be apparent that  
4 it is preferable for both irrigation and evacuation to be  
5 conducted along a single conduit which, also, acts as an  
6 access line for surgical instruments.

7 A typical device which is used in endoscopic procedures  
8 is an electrosurgical probe. Typically such a probe will  
9 comprise a radio frequency (i.e. R.F.) energy conductive  
10 tube covered with a dielectric material such as polyolefin  
11 or Teflon. At one end, for convenience called the  
12 operational end, each probe could have any one of a number  
13 of functionally shaped monopolar or bipolar electrodes.  
14 In addition a probe could have its end formed specifically  
15 for irrigation and/or evacuation.

16 Monopolar and bipolar electrode probes are known in the  
17 prior art. Monopolar electrode probes include a single  
18 active electrode which is surgically introduced into a  
19 body cavity and engagable with and insertable into a  
20 tissue portion of the cavity. A passive electrode is  
21 attached to the outer body surface of the patient, e.g.  
22 typically a conducting plate is adhesively attached to the  
23 patient's leg. The body of the patient serves to complete  
24 the electrical circuit. Tissue ablation and coagulation  
25 is achieved by introducing sufficient power into the  
26 active electrode. Bipolar electrode probes include both  
27 active and passive electrodes which are similarly  
28 introduced together into the body cavity and are spaced  
29 apart from each other by a predetermined distance. Each  
30 electrode is engageable with and insertable into the  
31 tissue portion. Thus, the electrical circuit is completed  
32 by the body tissue disposed between the active and the  
33 passive electrodes and only the body tissue disposed  
34 between the two electrodes get coagulated.

35 Furthermore, any valves controlling the evacuation and  
36 irrigation procedures should be constructed so as to  
37 minimize the possibility of the valve malfunctions if, for  
38 example, any tissue or blood coagulates around their

1 moving parts. Similarly if any of the instrumentation is  
2 to be reusable, such instrumentation, including the  
3 valves, should be capable of being efficiently cleaned by,  
4 for example, flushing.

5 United States Patent 4,668,215 (Allgood) discloses a  
6 valve for switching between an evacuation and an  
7 irrigation conduit and allowing both such evacuation and  
8 irrigation to be done via a single line entering the  
9 patient. The mechanism for switching between the  
10 irrigation, evacuation and closed configurations is by  
11 means of a L-valve or T-valve. This patent, in another  
12 embodiment thereof, further provides for a piston valve  
13 for making an on-off connection between an evacuation port  
14 and the line leading into the patient.

15 The L- and T-valves have the disadvantage that they must  
16 be manipulated by rotation by the surgeon, usually using  
17 his/her free hand. The piston valve disclosed in this  
18 patent has the disadvantage that it has many areas where  
19 blood and tissue accumulation and coagulation can occur  
20 which may result in the malfunctioning of the valve. In  
21 addition, the piston valve has numerous "dead" areas where  
22 fluid flow would not occur. This precludes the device  
23 from being effectively cleaned by commonly used flushing  
24 techniques. Finally, the Allgood patent does not disclose  
25 a single body for housing an evacuation/irrigation control  
26 valve together with a housing for laparoscopic and  
27 microsurgical instrumentation.

28 A surgical valve that the applicant is aware of is the  
29 piston valve illustrated in Fig. 1 of the accompanying  
30 drawings.

31 In this valve a piston 10 is located within a cylinder  
32 11. The piston 10 can be moved along the bore of the  
33 cylinder 11 by means of a plunger 12, from a closed  
34 position (as shown) to an open position in which a conduit  
35 13 is aligned with an access port 14. This allows fluid  
36 flow along a path to or from access port 14, via conduit  
37 13 and space 16 from or to a further port 15. Upon

1 release of the plunger 12 the piston 10 returns to its  
2 closed position under action of a spring 17.

3 This valve, although easy to use, has the disadvantage  
4 that blood and tissue accumulation occurs in space 16 and  
5 clogs both the space and the spring 17. This may result  
6 in undesirable over-evacuation or irrigation of the  
7 patient during surgical procedures.

8

9 OBJECTS OF THE INVENTION

10 It is therefore an object of this invention to provide  
11 a surgical instrument which includes control means to  
12 allow for the continuous irrigation and evacuation of a  
13 body cavity of a patient during microsurgical procedures,  
14 with both irrigation and evacuation being performed along  
15 a single line into the patient. The instrument should  
16 also act as a mounting for electrosurgical probes and  
17 microsurgical instruments.

18 A further object of the invention is to provide a  
19 configuration for an instrument which, depending on the  
20 material it is constructed of, can be both disposable and  
21 non-disposable. In the event that the instrument is  
22 "reusable" or "reposable" it is an object of the invention  
23 to provide the instrument with conduits, access ports and  
24 valves which can easily be cleaned by means of commonly  
25 used cleaning techniques and conventional sterilization  
26 methods.

27 It is another object of the invention to provide an  
28 electrosurgical instrument with fixed or retractable RF  
29 electrodes having the capability to simultaneously perform  
30 controlled ablation of tissue using monopolar/bipolar R.F.  
31 energy and precise measurement of tissue impedance.

32 SUMMARY OF THE INVENTION

33 According to this invention, an endoscopic surgical  
34 instrument comprises an irrigation and an evacuation port,  
35 each port being connected through independent valves to a  
36 single access conduit; a probe connector located at one  
37 end of the access conduit, the probe connector being for  
38 receiving and retaining a hollow surgical probe; and a

1 monopolar or bipolar radio frequency connector which exits  
2 into the access conduit in such a manner so as to make  
3 radio frequency connection with a probe received by the  
4 probe connector.

5 Preferably the connector for receiving an end, for  
6 convenience called the locating end, of the probe would be  
7 in the form of a receiving bore in the access conduit  
8 which would include a plurality of O-rings which provide  
9 a fluid-tight seal around the locating end of the probe.  
10 These O-rings also function to retain the probe in the  
11 receiving port while allowing the probe to be rotated. In  
12 one embodiment of the invention, the O-rings are, instead  
13 of being located within the receiving bore of the access  
14 conduit, located about the locating end of the probe.

15 This invention also provides for a valve, for use as  
16 either an evacuation or an irrigation valve, the valve  
17 comprising a housing, an activator connected to the  
18 housing, at least a first and a second valve access  
19 conduit, both of which exit into the housing and a fluid  
20 impervious seal mounted within the housing such that  
21 activation of the activator causes the first valve conduit  
22 to move axially relative to the seal and the second valve  
23 conduit such that the seal is disengaged and the conduits  
24 are placed in direct fluid communication with each other.

25 Typically, the instrument of the invention would contain  
26 two of the above described valves. One valve would act as  
27 an evacuator control while the other valve would act as an  
28 irrigation control. Both valves communicate into a single  
29 access conduit which, when the instrument is in use,  
30 continuously flows into the patient via the receiving bore  
31 and the hollow interior of the electrostatic probe.

32 Preferably the endoscopic surgical instrument of the  
33 invention is in the form of a pistol with the "barrel"  
34 portion thereof having, at one end thereof, the receiving  
35 bore for the locating end of the endoscopic probe and, at  
36 the other end thereof, the access port for the  
37 microsurgical instruments and endoscopes.

1        The valves for controlling the evacuation and irrigation  
2        procedures may be mounted in the "handle" portion of the  
3        pistolshaped instrument. The valves may be mounted  
4        alongside one another in the handle portion and may  
5        protrude therefrom to allow finger control by the surgeon  
6        using the instrument.

7        In one alternate embodiment of the invention the  
8        surgical instrument includes a housing, a single access  
9        conduit formed in the housing, an irrigation port and an  
10        evacuation port, each port being connected through  
11        independent valves to the single access conduit. The  
12        single access conduit has a first end, and a second end  
13        which is terminated in an aperture formed in the housing.  
14        A closure is provided for the aperture. A viewing device,  
15        such as an endoscope, is insertable through the aperture  
16        and into the single access conduit. The viewing device is  
17        of sufficient length such that it is extendable slightly  
18        beyond the first end. A retractable electrode assembly is  
19        also insertable through the aperture and into the single  
20        access conduit, and is of sufficient length such that it,  
21        too, is extendable beyond the first end. The retractable  
22        electrode assembly, in one embodiment, includes two  
23        retractable RF electrodes spaced apart by a predetermined  
24        width. Each RF electrode is made from a superelastic  
25        material, e.g. typically Nickel-Titanium (NiTi) metal, is  
26        sheathed within a guiding sheath, and is slidale within  
27        the sheath such that it is extendable beyond and  
28        retractable completely within the sheath. Also, each  
29        electrode is connected to a mechanism, operable by a  
30        surgeon, for moving the electrode within the sheath. Each  
31        electrode is extendable beyond its guiding sheath by a  
32        variable length and at a predetermined angle from a  
33        longitudinal axis of the single access conduit. Further,  
34        each electrode is electrically communicative with means  
35        for supplying R.F. energy and means for measuring  
36        impedance continuously on a realtime basis.

37        These and other objects and advantages of the present  
38        invention will no doubt become apparent to those skilled

1 in the art after having read the following detailed  
2 description of the preferred embodiment which is  
3 illustrated in the several figures of the drawing.

4 IN THE DRAWINGS

5 In the following drawings:

6 FIG. 1 is a partial sectional elevation through a prior  
7 art piston valve;

8 FIG. 2 is a diagrammatic section through a semi-explored  
9 elevation of one embodiment of the endoscopic surgical  
10 instrument of the invention;

11 FIG. 3 is an illustration of a tricuspid valved access  
12 port illustrated in plan (a) and elevation (b) views;

13 FIG. 4 is a section through a receiving bore of the  
14 instrument illustrating one way of locating a probe in the  
15 bore;

16 FIG. 5 is a section through a similar receiving bore  
17 showing a different way of locating a probe in the bore;

18 FIG. 6 is a side view illustrating in (a)-(i) various  
19 electrostatic probe operational ends;

20 FIG. 7 is a section through a valve according to the  
21 invention with the valve being in the shut position;

22 FIG. 8 is the valve of FIG. 7 in the open position;

23 FIG. 9 is a partial section through a different type of  
24 valve also suitable for use in the instrument of the  
25 invention;

26 FIGS. 10, 11, 12 and 13 are diagrammatic illustrations  
27 showing various configurations of valve operating buttons  
28 and triggers;

29 FIG. 14 is an exploded view of an alternative embodiment  
30 of the surgical instrument of the invention illustrating  
31 a disposable valve cartridge;

32 FIG. 15 is a cross section through the disposable valve  
33 cartridge illustrated in Fig. 14;

34 FIG. 16 is a partially sectioned view of another type of  
35 valve which can be used in the surgical instrument of the  
36 invention;

37 FIG. 17 is a perspective view of an alternate embodiment  
38 of the endoscopic surgical instrument having generally

1 similar valves, as illustrated in FIG. 7-8, and a  
2 retractable electrode assembly having bipolar RF  
3 electrodes in electrical communication with a R.F. energy  
4 source and a tissue impedance monitoring device;

5 FIG. 18 is a partial sectional view taken along the line  
6 18-18 of FIG. 17;

7 FIG. 19 is a view taken along the line 19-19 of FIG. 17;

8 FIG. 20 is a side elevation view of the retractable  
9 electrode assembly shown in FIG. 17;

10 FIG. 21 is an enlarged view of the tip of the  
11 retractable electrode assembly shown in FIG. 17;

12 FIG. 22A-22H illustrate alternate electrode  
13 configurations for the retractable electrode assembly  
14 shown in FIG. 17 and 20;

15 FIG. 23 is an enlarged view of the tip of the  
16 retractable electrode shown in FIG. 22D-22F; and

17 FIG. 24 is an alternate embodiment of the present  
18 invention including a retractable electrode assembly  
19 having a variable angle control mechanism.

20

21 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

22 In FIG. 2 of the accompanying drawings, the endoscopic  
23 surgical instrument of the invention is generally  
24 indicated as 20. The instrument 20 is shown to include an  
25 irrigation port 21 and an evacuation port 22. Each  
26 port, 21 and 22, is connected through independent valves  
27 23 and 24, respectively, to a single access conduit 25.  
28 The connection between the valves 23 and 24 and conduit 25  
29 is along connector tubes 23a and 24a.

30 The access conduit 25 leads from the valves and their  
31 respective valve conduits to a probe connector 26. This  
32 probe connector 26 is designed to receive one end, the  
33 locating end 27, of a surgical probe 28 which would be  
34 used during microsurgical procedures. The connection 26  
35 is described in more detail with reference to FIGS. 4 and  
36 5 hereafter.

37 At or near the probe connector 26, a monopolar/bipolar  
38 radio frequency connector 29 is located. As illustrated,

1       this is in the form of a R.F. connector. The advantage of  
2       a R.F. connector is that it is an industry standard and  
3       can be used for connecting the instrument 20 to standard  
4       R.F. energy sources marketed by a number of different  
5       manufacturers.

6       The radio frequency connector 29 exits into the access  
7       conduit 25 where it makes connection with a point 30, on  
8       the locating end 27 of a probe 28 received by the probe  
9       connector 26.

10      The surgical instrument 20 also includes a port 31 which  
11      allows the surgeon to insert microsurgical instrumentation  
12      and viewing devices along the access conduit 25 and the  
13      bore of the hollow probe 28 to exit from the end 32  
14      thereof. The port 31 should provide a fluid-tight seal  
15      when no microsurgical instrumentation is being used with  
16      the surgical instrument 20. This will prevent fluid,  
17      which may be moving along the access conduit 25 to or from  
18      the patient, from leaking.

19      Typically, the access port 31 is in the form of a  
20      commercially available tricuspid valve as illustrated in  
21      FIGS. 3(a) and (b). In these figures, the valve 31 is  
22      shown as being constituted by three segments 32 which in  
23      plan view are wedge-shaped and which together form the  
24      disc shaped sealing portion of the valve. The segments 32  
25      are held together by means of a circumferential ring 33  
26      which biases the three segments 32 together to form a  
27      fluid-tight seal. In use, the microsurgical  
28      instrumentation are inserted through the valve at a point  
29      34 where the apexes of the segments 32 come together.  
30      This insertion forces the elements of the valve apart to  
31      allow ingress of the microsurgical instrumentation. The  
32      effect thereof is shown in broken lines in FIG. 3(b).  
33      When the instrumentation is removed from the valve 31, the  
34      segments 32 are pulled together to form the seal.

35      In FIG. 4 the probe connector 26 is shown to be  
36      constituted by a receiving bore which is coaxial with the  
37      fluid access conduit 25. In practice, the diameter of  
38      this bore would be the same as that of the access conduit

1       25 and would be sized to receive the locating end 27 of  
2       the probe 28 in a relatively close fit. Within the bore  
3       forming the probe connector, a plurality, typically two,  
4       O-rings 36 are located. When the locating end 27 is  
5       inserted into the bore 26 these O-rings provide a snug,  
6       fluid-tight seal about the end 27. Once the locating end  
7       27 of the probe is received within the bore 26 it is  
8       capable of being rotated about its longitudinal axis, by  
9       means of a knurled rotation knob 37 located between the  
10      locating end 27 and the operational end 32 of the probe  
11      28.

12      The probe 28 would typically be made of a electrostatic  
13      conductive material coated with a non-conductive material  
14      such as heat shrink polyolefin or Teflon.  
15      Electrostatic/radio frequency energy is passed along the  
16      probe 28 from the radio frequency connector 29 via  
17      electrostatically conductive plates 38 located within the  
18      bore of the probe connector 26 and onto the end 30 of the  
19      probe 28. The end 30 is so designed such that when the  
20      locating end 27 of the probe is received by the probe  
21      connector 26, electrostatic connection is made between the  
22      plate 38 and the connector 30. This allows the surgeon to  
23      pass energy into the patient being operated on.

24      An alternative radio frequency connector is illustrated  
25      in FIG. 5. In this case, the R.F. connector 29 exits into  
26      the bore 26 in the form of a pin 39. In the conductive  
27      end 30 of the probe 28 an L-shaped slot 40 is formed. As  
28      the probe 28 is inserted into the receiving bore 26, the  
29      pin 39 engages the axially-orientated leg 41 of the L-  
30      shaped slot 40. When the probe can be inserted no further  
31      along the bore it is twisted, in this case in an anti-  
32      clockwise direction, such that the pin 39 and the axially  
33      transverse leg 42 of the L-shaped slot 40 engage each  
34      other to lock the probe 28 into position. In this  
35      embodiment the probe 28 cannot be rotated by means of the  
36      knurled knob 37.

1       FIG. 5 further illustrates an alternative positioning of  
2       the O-rings 36. In this case they are located on the  
3       locating end 27 of the probe 28.

4       From FIGS. 4 and 5, although not shown, it will be  
5       apparent that the diameter of the operational shank 28a of  
6       the probe 28 can be variable. Typically, the probe, as  
7       shown, would have a diameter of 5mm. This diameter can,  
8       however, be increased to 10mm which would be close to the  
9       diameter of the locating end 27 of the probe, as well as  
10       that of the internal bore diameter of the access conduit  
11       25. The advantage of 10mm diameter probes is that the  
12       evacuation of removed tissue and objects such as the gall-  
13       stones can be more effectively achieved. Obviously, when  
14       the bore of the operating shank 28a of the probe, the  
15       locating end 27 and the access conduit 25 are all 10mm in  
16       diameter, the diameter of the evacuation port 22 and its  
17       related valve 24 and connector tube 24a must also be 10mm.

18       In FIG. 6(a) to (i), a side view of number of different  
19       electrode shapes are illustrated. It will be appreciated  
20       that the electrode tips could be either monopolar or  
21       bipolar. In the case of bipolar electrodes, only one  
22       electrode is illustrated since a second electrode is fully  
23       obscured by the visible electrode. These electrode tips  
24       would be located on the operating end of the probe 28.

25       As can be seen from the figure, a number of the tips are  
26       not symmetrical about the longitudinal axis of the probe  
27       28. It is for this reason that it is desirable for the  
28       probe 28 to be mounted on the instrument in such a manner  
29       to allow for a rotation of the probe about its  
30       longitudinal axis. As has been previously indicated, this  
31       will give the surgeon the opportunity of rotating any non-  
32       symmetrical tips, inside the patient, without having to  
33       rotate his or her wrist.

34       This invention extends also to an electrostatic probe  
35       28, substantially as described in any of the FIGS. 4 to 6.

36       The details of one type of irrigation/evacuation valve  
37       are illustrated in FIGS. 7 and 8. The valve 24 indicated  
38       in both figures comprises a housing constituted by a

1 hollow tube 50 and an activator in the form of a button 51  
2 formed integrally with the tube 50. A fluid impervious  
3 seal 52 is located within the tube 50. Referring  
4 specifically to FIG. 7, in which the valve is shown in the  
5 shut position, it can be seen that the seal 52 lies  
6 between a first valve conduit 53 which leads to the  
7 evacuation port 22 (not shown) and a second valve conduit  
8 in the form of connector tube 24a which leads into the  
9 primary access conduit 25 of the surgical instrument. In  
10 effect, the seal 52 prevents the conduits 53 and 24a from  
11 being in communication with each other.

12 The first valve conduit 53 is mounted onto the wall of  
13 the tube 50 and opens into the interior of the tube 50  
14 through a hole 54. Between the seal 52 and the button  
15 portion 51 of a tube 50, a spring 55 is located. On the  
16 side of the seal 52, opposite to which the spring is  
17 located, a tubular insert 56 is located. This tubular  
18 insert has a snug but slidible fit over the outer wall of  
19 the second valve conduit 24a as well as a tight, fluid  
20 impervious fit into the inner bore of the tube 50. This  
21 tube 56 acts as a stop which prevents the spring 55 from  
22 pushing the seal 52 out of the hollow tube 50.

23 To open the valve, as is illustrated in FIG. 8, an  
24 activating force, applied along a line F to the button 51,  
25 will cause the button to move from the position indicated  
26 in broken lines to the illustrated open-valve position.  
27 As the button moves, so does the hollow tube 50, taking  
28 the first valve conduit 53 along with it. In addition,  
29 the leading edge 57 of the second valve conduit 24a bears  
30 against the seal 52 causing the seal to move relatively to  
31 the tube 50. This in turn disengages the seal from  
32 sealing the hole 54 in the wall of the tube 50. The  
33 movement of the first valve conduit 53, relative to the  
34 second valve conduit 24a, places the respective openings  
35 54 and 58 of these two conduits in fluid communication  
36 with each other thereby allowing an unobstructed fluid  
37 flow along both access conduits.

1       Upon release of the force on the button 51, the bias of  
2       the spring 55 will return the valve to its shut position.

3       It is evident from the construction of the valves  
4       illustrated in FIGS. 7 and 8 that they can be readily  
5       cleaned by commonly used cleaning such as flushing. In  
6       addition, the valves have almost no areas where blood and  
7       tissue accumulation and coagulation can occur, and if such  
8       accumulation and coagulation does occur the valves cannot  
9       be jammed in the open position. This is because the  
10      spring biasing the valve into its closed position is  
11      located in an effectively sealed area. Furthermore these  
12      valves have been tested to a pressure of up to 100 psi  
13      without the integrity of the valve seal being adversely  
14      affected.

15      An alternative form of valve, to that illustrated in  
16      FIGS. 7 and 8 above, is shown in FIG. 9. In the figure  
17      the valve is shown to include a generally cylindrical  
18      valve body 60, an activating button 61 and a plunger 62.  
19      A hollow bore runs down the center of the valve body 60  
20      and contains the valve seal 63. The valve seal 63 is made  
21      up of a circular washer 63a and a sealing O-ring 63b and  
22      is screwed onto the bottom of plunger 62. The valve seal  
23      63 is biased into its illustrated sealing position by  
24      means of a spring 64 located in the bottom part of the  
25      valve body 60.

26      To open the valve, the button 61 is depressed so that  
27      the plunger 62 forces the valve seal 63 downwards against  
28      the bias of the spring 64 to a position shown in broken  
29      lines 63', in the figure. As a result, a fluid path,  
30      indicated by arrows 65, is opened between an upper pair of  
31      cutouts 66 and a lower pair of cutouts 67. Each pair of  
32      cutouts opens into the hollow bore in the center of the  
33      valve body 60 and, when this valve is inserted into the  
34      surgical instrument, into either an evacuation or  
35      irrigation conduit. Closure of the valve is achieved by  
36      releasing the button and allowing the spring 64 to return  
37      the valve seal 63 to the sealing position.

1       One advantage of this embodiment of the valve is that it  
2       is easily removed from and inserted into the surgical  
3       instrument of the invention. Accordingly the valve can  
4       easily be removed for cleaning or disposal and  
5       replacement. This is further illustrated below with  
6       respect to FIG. 13. It is sufficient here to mention only  
7       that the surgical instrument is provided with a receiving  
8       bore for each valve and that the valve includes a  
9       plurality (in this case 3) O-rings 68 which, when the  
10      valve is inserted into its respective receiving bore,  
11      provide a number of fluid tight seals against the inside  
12      of the bore.

13      Either of the two types of valve described in FIGS. 7 to  
14      9 can be used on the instrument 10. Typically one valve  
15      would act as an evacuation valve while the other as an  
16      irrigation valve. Different types of arrangements of  
17      valves and valve activation means are illustrated in the  
18      following 4 figures.

19      One way of activating the valve is by means of a rocker-  
20      shaped trigger 70 illustrated in FIG. 10. The trigger 70  
21      is pivotally mounted on a point 72 on the handle 74 of the  
22      pistol. Depressing the trigger 70 to operate the  
23      irrigation valve 71 would not interfere with the operation  
24      of the evacuation valve 73. Similarly, operation of the  
25      trigger 70 to operate the evacuation valve 73 would in no  
26      way effect the operation of the irrigation valve.

27      In FIG. 11 a trigger mechanism 76 is shown for operation  
28      of only one of the buttons. The other button 78 would be  
29      located for operation by means of the surgeon's thumb in  
30      a position removed from the trigger 76. This could, for  
31      example, be near the top end of the handle portion of the  
32      instrument.

33      Yet a further positioning of the buttons 71 and 73 is  
34      indicated in FIG. 12. In this instance, the buttons  
35      protrude from the top rear of the pistol handle and are  
36      located side-byside. To prevent confusion between  
37      evacuation and irrigation procedures, the tops of the  
38      buttons have different shapes. So, for example, the

1 button to manipulate the evacuation valve could be concave  
2 while the button for manipulating the irrigation valve  
3 could be convexly shaped.

4 FIG. 13 illustrates still another arrangement of buttons  
5 and valves, in this case an arrangement particularly  
6 suited to the valve shown in FIG. 9.

7 In this figure only the pistol grip 90 of the surgical  
8 instrument of the invention is shown. An irrigation port  
9 92 and evacuation port 94 enter the pistol grip 90 at the  
10 bottom of its handle portion. The ports 92, 94 are, in  
11 use, respectively connected to irrigation and evacuation  
12 conduits (not shown) and, to this end, suitable  
13 connectors, as illustrated, are provided.

14 The irrigation port 93 communicates with the main access  
15 conduit 96 (referenced as 25 in FIGS. 2, 4 and 5) along an  
16 irrigation conduit 98 which extends from the irrigation  
17 port 93 and into the rear of the bore 100 which houses an  
18 irrigation valve 102. From there it extends along the  
19 bore 100 to a point near the front of the bore from where  
20 it exits into the body of the grip 900 to enter rear of  
21 the bore 104 which houses an evacuation valve 106. The  
22 irrigation conduit extends directly across the bore 104 at  
23 this point and becomes a central conduit 108 which  
24 communicates with the access conduit.

25 On the other hand, the evacuation port 94 communicates  
26 with an evacuation conduit 105 which extends along the  
27 pistol grip 90 directly into the front of the bore 104,  
28 down to the bore 104 to its rear from where it exits into  
29 the central conduit 108.

30 In the position shown, both the irrigation and  
31 evacuation valves 102, 106 respectively, are shown in the  
32 off or shut configurations and neither evacuation or  
33 irrigation can take place. Should irrigation of the  
34 patient be required, the dish-shaped irrigation button 110  
35 is depressed and the valve 102 opens (ie. its valve seat  
36 moves to the right in the drawing) to allow irrigation  
37 fluid to pass along the irrigation conduit 98 and into the  
38 bore 104. In this bore 104 the evacuation valve 106 is in

1 the off configuration. However, a fluid path exists  
2 across the pair of cutouts (67 in FIG. 9) and therefore  
3 the irrigation fluid can pass through the body of the  
4 valve 106 and into the central conduit 108 and, from  
5 there, into the access conduit 96.

6 When evacuation is desired the irrigation button 110 is  
7 released and the spring associated with the irrigation  
8 valve 102 biases it into the shut or off configuration.  
9 Thereafter the flat topped evacuation button 112 is  
10 depressed to open the evacuation valve 106. This allows  
11 the patient to be evacuated along the main access conduit  
12 96, into the central conduit 108, then from the rear to  
13 the front of the bore 104 and, from there, out along the  
14 evacuation conduit 105.

15 As has been indicated earlier, the valves 102, 106 are  
16 easily inserted into and removed from their respective  
17 bores 100, 104. This allows the pistol grip 90 (which is  
18 typically stainless steel and is reusable) to be cleaned  
19 efficiently. The valves, typically being of plastic and  
20 being difficult to clean, can be discarded and replaced  
21 with new valves.

22 A variation on this theme of discardable valves is  
23 illustrated in FIG. 14. In this figure the surgical  
24 instrument is shown to include a pistol grip 120, a  
25 surgical probe 122, which can be screwed into the front of  
26 the pistol grip 120 and a radio frequency connector 124  
27 which screws into the back of the grip 120.

28 The instrument also includes a removable (and  
29 disposable) valve cartridge 126. The cartridge 126  
30 includes an irrigation pipe 128 and an evacuation pipe 130  
31 both of which are individually operated by valves (as will  
32 be further illustrated in FIG. 15) under action of button-  
33 shaped actuators 132. Both the irrigation and evacuation  
34 pipes communicate into a single conduit (not shown) which  
35 runs down the center of a male connector fitting 134.  
36 Where the cartridge 126 is inserted into the grip 120 the  
37 connector 134 fits into the base of a central conduit 136  
38 which, in turn, opens up into the main access conduit 138

1 of the instrument. When the cartridge 120 is located in  
2 the grip 120 the actuators 132 are located directly below  
3 a pair of operating triggers 140 which can be used to  
4 operate the irrigation/evacuation procedures described  
5 before.

6 Finally, when the cartridge 120 is in place, it is held  
7 there by means of a retainer clip 142 which clips in  
8 behind the cartridge 120. The retainer clip 142 has  
9 apertures 144 formed in it to allow the irrigation and  
10 evacuation pipes 128, 130 to pass through it.

11 Although it will be apparent that the valve types  
12 described above are also suitable for use in the cartridge  
13 120, a further valve configuration is illustrated in FIG.  
14 15, which illustrates the cartridge 120 in greater detail.

15 In this figure, the cartridge 120 is shown to include an  
16 irrigation conduit 150 and an evacuation conduit 152, both  
17 of which lead to a central access conduit 154 which  
18 extends down the center of the male connector 134.  
19 Irrigation and evacuation procedures are controlled by  
20 irrigation and evacuation valves 156 and 158,  
21 respectively.

22 The irrigation valve 156 consists of a valve seal 160  
23 mounted onto a stem which is screwed into an activator  
24 button 132a. A fluid tight seal is provided for the valve  
25 156 by an O-ring 168 mounted onto the cap 132a. The valve  
26 seal 160 seals against a valve seat, formed at the  
27 junction between the irrigation conduit 150 and the  
28 central access conduit 154 and is held in the sealing  
29 position (as shown) by a spring 162.

30 Access to the valve seat is through a hole 164 formed  
31 into the top (as shown in the drawing) of the cartridge  
32 120. This hole 164 can be closed off with a cap 166 and  
33 allows the irrigation valve 156 to be inserted into the  
34 cartridge 120. This is done by inserting the valve seal  
35 160 and its associated stem into the hole 164 from above  
36 and inserting the spring 162 from below. Thereafter the  
37 cap 132a can be screwed onto the stem to hold the entire  
38 valve 156 in place.

1        To operate an irrigation procedure the button 132a is  
2        depressed to move the valve seal 160 clear of its seal to  
3        open a fluid path between the irrigation conduit and the  
4        central access conduit. Releasing the button 132a causes  
5        the spring 162 to force the seal 160 back into its seat  
6        thereby automatically shutting the valve.

7        The evacuation valve 158 is of a different construction.  
8        In this valve 158, the valve seal 170, in its off position  
9        as shown, seals the mouth of the evacuation conduit 152.

10       In operation, the seal 170 is moved under action of a  
11       plunger and evacuation button 132b from the position shown  
12       to a position 170' in which an end of a conduit 174,  
13       formed through the seal 170, aligns with the central  
14       access conduit 154. At the same time the other end of the  
15       conduit 174 is aligned with the evacuation conduit 152 and  
16       evacuation can be accomplished. By releasing the button  
17       132b, the spring 172 biases the seal 170 back into its  
18       sealing position.

19       Assembly of this evacuation valve 158 is by inserting  
20       the entire valve mechanism into its valve bore and sealing  
21       a collar 176 in the bore.

22       As has been indicated with reference to FIG. 14, the  
23       cartridge 120 is of the disposable type and is intended  
24       for use only once. Accordingly the considerations of  
25       valve flushing (during cleaning) are not entirely  
26       applicable here.

27       In FIG. 16 yet another type of valve, which can be used  
28       as either an irrigation or an evacuation valve, is  
29       illustrated.

30       The valve, generally indicated as 180, is shown to  
31       include a hollow cylindrical valve body 182 which is  
32       sealed at its lower end by a valve seal 184 and at the  
33       other by an activator button 186. The activator button  
34       186 seals against the valve body with an O-ring 188 and is  
35       connected to the valve seal 184 by means of a plunger 190.

36       To open the valve 180, the button 186 is depressed  
37       against the bias of a spring 192 to move the valve seal  
38       184 to the position indicated in broken lines. This opens

1 a fluid path 194 between an opening 196 formed in the  
2 sidewall of the valve body and its lower end. Releasing  
3 the button 186 allows the spring 192 to force the seal 184  
4 back into the closed position.

5 One advantage of this valve is that it is very simple  
6 and inexpensive to manufacture and can, therefore, readily  
7 be disposed of.

8 Finally, it will be apparent to anyone skilled in the  
9 art, that the surgical instrument of this invention could  
10 be made from any suitable material. In the event that the  
11 instrument is intended for single use, plastic material  
12 could be used. Alternatively, for reusable or reposable  
13 instrument, the instrument can be made of a more durable  
14 material.

15 FIG. 17 is a perspective view of an endoscopic surgical  
16 instrument 200 which is an alternate embodiment of the  
17 surgical instrument 20 described above. FIG. 18 is a  
18 partial sectional view of a portion of the instrument 200  
19 taken along the line 18-18 of FIG. 17 and FIG. 19 is  
20 another view of the instrument 200 taken as indicated by  
21 the line 19-19 of FIG. 17. FIG. 20 illustrates the  
22 retractable electrode assembly 202. When viewed together,  
23 FIG. 17-20, illustrate the instrument 200 including an  
24 endoscopic instrument 201, a retractable RF electrode  
25 assembly 202, an continuous irrigation and evacuation  
26 assembly 203, a R.F. energy source 285, and a tissue  
27 impedance monitoring device 284. It will be appreciated  
28 that, although two retractable RF electrodes are  
29 illustrated and subsequently described, in alternate  
30 embodiments the retractable electrode assembly could have  
31 one or more than two retractable RF electrodes. Also,  
32 although a bipolar retractable RF electrode assembly is  
33 illustrated and subsequently described, it will be  
34 appreciated that a monopolar retractable RF electrode  
35 assembly could be used.

36 The assembly 203 includes a housing 210, an irrigation  
37 valve assembly 214, and an evacuation valve assembly 220.  
38 The housing 210 includes an elongated portion 228 having

1 a generally oval cross section. The portion 228 includes  
2 a free tip end 230 and a secured end which is attached to  
3 a handle portion 232. The portion 232 is held by the  
4 surgeon, and the portion 228 is surgically introduced into  
5 a body cavity (not shown) of the patient. A single access  
6 conduit 212 (a portion of which is best seen in FIG. 18  
7 and 19) is formed between an inner surface of the portion  
8 228 and the objects carried within the portion 228. The  
9 conduit 212 is disposed along the entire longitudinal  
10 length of the portion 228 and is functionally similar to  
11 the conduit 25 (FIG. 2) in that it permits the irrigation  
12 and evacuation of fluids into and out from the body cavity  
13 into which the portion 228 is inserted. The conduit 212  
14 is open at the tip end 230 and can be accessed, at its  
15 opposite end, via an aperture and associated closure 226  
16 formed in the handle portion 232. The closure 226 is in  
17 the form of a tricuspid valve and is substantially similar  
18 to the valve 31 illustrated and described above (FIG. 2).

19 The irrigation valve and the evacuation valve assemblies  
20 214, 220 are substantially similar to the irrigation and  
21 evacuation valves 23, 24 described above (FIG. 2). The  
22 valve assemblies 214, 220 operate in a similar manner to  
23 valves 23, 24 (FIG. 7, 8). Depressing the valve  
24 assemblies 214 or 220 permits the communication of fluid  
25 in a valve first conduit 216 (or 222) with a valve second  
26 conduit 218 (or 224). Each of the valve second conduits  
27 218 and 224 are in fluid communication with the conduit  
28 212 (in the same manner that the conduits 23a, 24a are in  
29 fluid communication with the conduit 25, FIG. 2). Thus,  
30 when the valve assembly 214 is operated, irrigation fluid  
31 can be communicated to the conduit 212 and out through the  
32 tip end 230, and delivered to the body cavity. In a  
33 similar manner, fluids in the body cavity can be evacuated  
34 if the valve assembly 220 is operated.

35 The retractable electrode assembly 202 includes a means  
36 for guiding the angular orientation of the electrode or  
37 guide sheath 248, an endoscope sheath 238, a electrode  
38 movement mechanism 236, a tissue impedance measurement

1 device 284, and a R.F. energy source 285. The sheath 248  
2 is generally parallel to the scope sheath 238. The sheath  
3 248 and the sheath 238 are each insertable into an opening  
4 of an insert flange 242, into the aperture of the handle  
5 portion 232 of the assembly 203. The sheath 248 and the  
6 sheath 238 are insertable within the conduit 212 and are  
7 each of sufficient length such that when each is fully  
8 inserted within the conduit 212, each extends slightly  
9 beyond the tip end 230 of the cylindrical portion 228.

10 The endoscopic instrument or endoscope 201 is  
11 substantially similar to the endoscope instrument  
12 described above, and can be any of a number of devices  
13 known in the prior art. An eyepiece 204 is shown attached  
14 to the endoscope 201. The endoscope 201 is slid into the  
15 scope sheath 238 until the eyepiece 204 engages a flange  
16 240 which is attached to the sheath 238. Thus, the  
17 endoscope 201, and the sheath 248 of the retractable  
18 electrode assembly 202 are both insertable within the  
19 portion 228 of the irrigation and evacuation assembly 203.

20 Each of two RF electrodes 250a, 250b is sheathed within  
21 its respective guide sheath 248a, 248b. Although the  
22 illustrated embodiment depicts two RF electrodes, it will  
23 be appreciated that the assembly 202 could have one or  
24 more than two electrodes. Each electrode 250a, 250b  
25 includes a first or distal end 249a, 249b, a second, or  
26 proximal end 247a, 247b, and a central portion (not shown)  
27 disposedly connected therebetween. A coating of  
28 insulation 246 is disposed onto the bare electrode 250.  
29 The insulation coating 246 may be in the form of a tube of  
30 material (such as teflon) heat shrunk around the bare  
31 electrode 250. Alternately, the insulating coat 246 may  
32 be powder deposited, using vacuum deposition techniques,  
33 onto the bare electrode 250. In either case, nearly the  
34 entire length of the bare electrode 250 is covered by the  
35 insulating coat 246.

36 The electrodes 250a, 250b have a generally constant  
37 diameter throughout its entire length and are sized such  
38 that they can be slid within the sheaths 248a, 248b. That

1 is, there exists a sufficient clearance (e.g. 0.005 inch)  
2 between the outside diameter of each of the insulating  
3 coats 246a, 246b of the electrodes 250a, 250b and the  
4 inner diameter of the respective sheaths 248a, 248b. Each  
5 electrode 250a, 250b is made from a superelastic metal  
6 material, e.g. typically a Nickel-Titanium (NiTi) metal  
7 alloy. The guide sheaths 248a, 248b are made from a rigid  
8 plastic or coated metal tubing which forms a rigid conduit  
9 that guides, i.e. deforms, the electrode along a  
10 predetermined path.

11 As best seen in FIG. 19, the electrodes 250a, 250b and  
12 their respective sheaths 248a, 248b are contained within  
13 the cross sectional envelope of the portion 228. Thus,  
14 the required incision into the patient need only  
15 accommodate the cross sectional area of the portion 228.  
16 The presence of the extendable electrodes does not  
17 increase the size of the required incision. It should be  
18 also noted that each electrode 250a, 250b descends  
19 downwardly into the field of view of the endoscope 201.  
20 In this manner the surgeon is able to view the extension  
21 of each electrode 250a, 250b beyond the end of the sheath  
22 248a, 248b.

23 The two electrodes 250a, 250b and their respective  
24 insulators 246a, 246b are encased within their respective  
25 guide sheaths 248a, 248b which are encased within a  
26 plastic insulating covering 244. The electrodes 250a and  
27 250b encased within the plastic covering 244 exits the  
28 housing 232 through the opening in the flange 242.

29 Each electrode 250a, 250b is in parallel electrical  
30 communication with a tissue impedance measuring device 284  
31 and a R.F. energy source 285. The covering 244 enters the  
32 movement mechanism 236 through an opening 260 formed in a  
33 sleeve 256 of the mechanism 236. The electrodes 250a,  
34 250b and their respective insulators 246a, 246b exit from  
35 the covering 244 and each of the second ends 247a, 247b,  
36 of each of the electrodes 250a, 250b are attached to  
37 connecting pins 272a, 272b, respectively. The connecting  
38 pins 272a, 272b are mounted at an end of a plunger 264.

1        Each connecting pin 272a, 272b is in communication with a  
2        wire 274a, 274b each of which passes through the plunger  
3        264, through an opening 278, and into an insulated line  
4        276 which is terminated in a plug 280 which is matingly  
5        engagable with a receptacle 282 of the tissue impedance  
6        measuring device 284.   The R.F. source 285 is in  
7        electrical communication with the impedance measuring  
8        device via electrical lines 283a and 283b.   The source 285  
9        and the impedance measuring device 284 are connectable in  
10      parallel in order to get realtime impedance measurement of  
11      tissue engaged between the first ends 249a, 249b of each  
12      of the electrode 250a, 250b.

13      The movement mechanism 236 includes a finger ring  
14      portion 252, and a thumb ring portion 254.   The finger  
15      ring portion 252 is a generally flat plate having finger  
16      loops 251a, 251b formed therein.   A passage 262 is formed  
17      through the finger ring portion 252 such that the  
18      longitudinal axis of the passage 262 is disposed between  
19      each finger loop and lies coplanar with the plane of each  
20      finger loop.   The sleeve 256, and a cylinder 258 are  
21      partially inserted into opposite ends of the passage 262.  
22      The sleeve 256 has a passage longitudinally formed therein  
23      so as to receive the covering 244.   The cylinder 258 has  
24      a passage longitudinally formed therein which is aligned  
25      with the passage of the sleeve.   The plunger 264 is  
26      slidable within the passage of the cylinder 258.   One end  
27      of the plunger is attached to the thumb ring portion 254,  
28      and the connection pins 272a, 272b are mounted to the  
29      other end of the plunger 264.   The outer surface of the  
30      plunger 264 is visible through an access cutout 270 formed  
31      in the cylinder 258.   In one embodiment, an indicator post  
32      266 is attached to the outer surface of the plunger 264  
33      and passes through the access cutout 270 to give an  
34      immediate visual indication of the position of the plunger  
35      264 within the cylinder 258.   In a preferred embodiment,  
36      the outer surface of the plunger 264 is scored with a  
37      plurality of indicator marks 268 to provide a visual  
38      indication of the position of the plunger 264 within the

1 cylinder 258, which corresponds to variable length of  
2 extension of each of the electrodes beyond their  
3 respective insulating sheaths.

4 In operation, the irrigation and evacuation valves, and  
5 the endoscope operate as described above. Regarding the  
6 retractable electrode assembly 202, a free hand of the  
7 surgeon is used to operate the movement mechanism 236.  
8 The surgeon's fingers are engaged within the finger ring  
9 loops and the thumb is engaged within the thumb ring  
10 portion. The thumb either pushes or pulls on the thumb  
11 ring thereby moving the attached plunger 264 into or out  
12 of the cylinder 258 and the passage 262. As the plunger  
13 264 moves each of the first ends 249a, 249b of each of the  
14 electrodes 250a, 250b move because the connection pins  
15 272a, 272b mounted to the plunger are attached to each of  
16 the second ends 247a, 247b of each of the electrodes 250a,  
17 250b. Thus, as the plunger moves in the direction of the  
18 arrow A, the central portions of each of the electrodes  
19 moves within their respective insulators in the direction  
20 of the arrow B, and the first ends 249a, 249b move in the  
21 direction of the arrow C.

22 FIG. 21 illustrates the first end 249 of the electrode  
23 250. The guide sheath 248 is formed with a bend at one  
24 end. The electrode 250 slides within the sheath 248 and  
25 exits the sheath 248 under the guidance of the sheath 248.  
26 The insulating cover 246 permits the easy sliding of the  
27 electrode within the sheath 248. Although a bend of 90  
28 degrees is illustrated, it will be appreciated that a bend  
29 of any angle may be formed in the sheath 248 so as to  
30 guide the electrode 250 into a variety of angular  
31 dispositions. It should be noted that the electrode 250  
32 is bare in the vicinity of the first end 249. A  
33 predetermined length value L, measured from the tip of the  
34 electrode to the end 255 of the insulating coat 246,  
35 represents the length of the electrode 250 that is bare or  
36 uncoated. Typical values for L range from 0 to 3 cm.

37 The first ends of each electrode extends beyond its  
38 respective sheath 248 by a length greater than the

1 predetermined extension length  $L$  in order to permit the  
2 bare electrode to penetrate a tissue portion up to the  
3 full  $L$  value. Further, the first ends of each needle  
4 electrode are separated by a predetermined separation  
5 width  $W$  (typically 0.1-2.0 cm) and each first end forms a  
6 predetermined angle  $\theta$  with respect to the longitudinal  
7 axis of portion 228. In the illustrated embodiment, the  
8 angle  $\theta$  is 90 degrees. Typical values for  $\theta$  range between  
9 0 and 360 degrees.

10 During surgical procedures, the tip end 230 of the  
11 portion 228 of the instrument 200 is brought adjacent to  
12 a target tissue area of the body cavity. The first ends  
13 of each electrode are extended beyond their respective  
14 sheaths such that each first end is embedded into the soft  
15 target tissue area thereby defining a tissue portion  
16 engaged between the adjacent first ends of each electrode.  
17 The power source is energized and R.F. energy is  
18 transmitted from one electrode to the adjacent electrode.  
19 The energy transmission causes a coagulation of the tissue  
20 portion engaged between the adjacent electrodes and  
21 ablation of the target tissue.

22 Using the present invention, the surgeon can predict and  
23 control the amount of tissue ablation/coagulation with  
24 greater accuracy and safety. As described above, the  
25 spacing between the two parallel first ends of each  
26 electrode remains constant at some predetermined  $W$  value,  
27 e.g. 1.0 cm. Also, the extension of the electrodes beyond  
28 the insulators at a given angle, i.e. the depth of  
29 penetration of each first ends of each electrode into the  
30 soft tissue portion, can be precisely controlled by  
31 observing the indicator marks on the plunger.  
32 Predictable and precise tissue ablation is therefore  
33 possible with the present invention because the depth of  
34 each first end of each electrode in soft tissue can be  
35 precisely controlled by the surgeon. That is, the surgeon  
36 can predict a cylindrical zone of ablation by controlling  
37 the depth of the retractable first ends into the soft  
38 tissue portion. This precise depth control enables the

1       surgeon to predict the zone of ablation with greater  
2       accuracy and safety than prior art non-retractable  
3       monopolar RF devices, or prior art laser delivery systems.

4       The cellular structure of body tissue contains water  
5       which is a conductor of electrical energy. Consequently,  
6       a portion of body tissue also has an associated resistance  
7       or impedance value. In prior art monopolar electrode  
8       devices, tissue impedance is difficult to measure.  
9       However, in the present invention, precise impedance  
10      measurement of the soft tissue in the proximity of the  
11      bipolar electrodes is possible. In the present invention,  
12      during the tissue coagulation process simultaneous  
13      measurement of the impedance of the tissue engaged between  
14      the extended first ends of the electrodes signals the  
15      completion of the tissue coagulation process and provides  
16      assurance and confirmation to the surgeon.

17      R.F. energy applied to the tissue engaged between the  
18      first ends of the two electrodes causes the tissue to  
19      coagulate which decreases the water content associated  
20      with the tissue. As the water content decreases the  
21      conductivity of the tissue decreases. For a constant R.F.  
22      energy, as the conductivity decreases the impedance (or  
23      resistance) associated with the tissue increases. The  
24      tissue impedance is highest when the tissue is completely  
25      coagulated, since coagulated tissue has a minimum amount  
26      of water content and current flow is blocked from one  
27      electrode to the other electrode. However, at the  
28      beginning of the ablation procedure, the tissue impedance  
29      is at a minimum because the water content of the tissue is  
30      at its highest level and the tissue is a good conductor  
31      and allows the maximum current to flow from one electrode  
32      to the other. During the ablation procedure, as the  
33      tissue coagulates the water content decreases and the  
34      tissue impedance increases. The tissue impedance  
35      measurement device 284 can be designed to transmit an  
36      variable frequency audible signal, i.e. a beeping tone,  
37      when the tissue impedance is at its lowest value. As more  
38      tissue is ablated and as the tissue impedance reaches its

1 highest value the audible signal decreases in frequency.  
2 In the present invention, the tissue impedance is  
3 monitored or measured on a relative basis. That is, the  
4 impedance measured or monitored is the impedance of the  
5 tissue engaged between the two needle electrodes.

6 FIG. 22A through 22H illustrate alternate electrode  
7 configurations. It will be noted that the preferred  
8 embodiment of the present invention includes two  
9 electrodes with a  $\theta$  of 90 degrees, and a L value of 0-3  
10 cm, and a W value of 0.1-2.0 cm. It will be appreciated  
11 that a variety of electrode configurations, with  
12 associated L, W, and  $\theta$  values within the above specified  
13 ranges, are possible. However, it is generally preferable  
14 to limit the total number of electrodes to six or less.

15 It will be noted that in the embodiments illustrated in  
16 FIG. 22A-22C, 22G-22H, the electrodes 250 are guided by  
17 the shape of the sheath 248. That is, the electrodes can  
18 be directed towards or away from each other if the guide  
19 sheaths are angled towards or away from each other.  
20 Similarly, different  $\theta$  values are possible if the sheaths  
21 are formed with the appropriately angled bends.

22 However, in the embodiments illustrated in FIG. 22D-22F,  
23 the sheaths are substantially straight and the electrodes  
24 themselves are bent in order to direct them in certain  
25 orientations. This feature is more clearly shown in FIG.  
26 23 which illustrates a typical electrode having a bend  
27 formed at the location depicted by numeral 257. When the  
28 electrode is disposed within the sheath 248, the electrode  
29 250 is in contact with at least one portion 259 of the  
30 inner surface of the sheath 248 because of the bend 257.  
31 When the electrode is extended beyond the sheath (shown in  
32 phantom lines), the electrode "flattens" within the sheath  
33 248 while the electrode tip angles away from the sheath  
34 centerline in accordance with the bend 257 formed in the  
35 electrode.

36 FIG. 24 illustrates a retractable electrode surgical  
37 instrument 300 which is an alternate embodiment of the  
38 retractable electrode instrument 200 (FIG. 17). The

1 instrument 300 includes many of the same elements as the  
2 instrument 200. These identical elements are identified  
3 with the same reference numeral as shown in FIG. 17. In  
4 this embodiment, each electrode 250a, 250b is enclosed  
5 within a bendable guiding sheath 290a, 290b. A guide wire  
6 293a, 293b is disposed within each sheath 290a, 290b and  
7 includes a first end 289a, 289b and a second end 291a,  
8 291b. Each first end 289 of each guide wire 293 is  
9 attached (e.g. welded or adhesively bonded) to an inner  
10 surface of a bendable or bellows portion 292 of the sheath  
11 290 at a location proximate the open end of the sheath  
12 290. Each second end 291 is attached to a lever or knob  
13 294 which is mounted to an outer surface of a housing 291.  
14 The housing 291 is similar to the housing 232 and includes  
15 communication ports for an irrigation valve and an  
16 evacuation valve (neither shown). In operation, when  
17 there is no tension on the guide wires the sheaths are  
18 straight within the conduit, i.e.  $\theta$  is 0 degrees. As the  
19 surgeon pulls back on the knob or lever, the wires are  
20 tensioned and the tips of each sheath is pulled back as  
21 illustrated until a desired  $\theta$  value is obtained. In this  
22 embodiment, both the L and the  $\theta$  values can be adjusted by  
23 the surgeon in situ.

24 Although the present invention has been described above  
25 in terms of a specific embodiment, it is anticipated that  
26 alterations and modifications thereof will no doubt become  
27 apparent to those skilled in the art. It is therefore  
28 intended that the following claims be interpreted as  
29 covering all such alterations and modifications as fall  
30 within the true spirit and scope of the invention.

What is claimed is:

CLAIMS

1. An endoscopic surgical instrument comprising:  
2      a) a housing;  
3      b) a single access conduit being disposed within said  
4      housing, and having a proximal end and a distal end;  
5      c) an irrigation port formed in said housing;  
6      d) an evacuation port formed in said housing, each of  
7      said irrigation and said evacuation ports being in fluid  
8      communication, through independent valves, with said  
9      proximal end of said single access conduit;  
10     e) an aperture and a closure therefor, said aperture  
11    being formed in said housing, and said closure being  
12    openable to allow the ingress of microsurgical  
13    instrumentation into said proximal end of said single  
14    access conduit; and  
15     f) RF electrode means insertable into said aperture  
16    and into said single access conduit and having a length so  
17    as to protrude beyond said distal end of said single  
18    access conduit, said RF electrode means for engaging a  
19    body tissue portion, and for simultaneously ablating said  
20    body tissue portion and measuring an impedance value  
21    associated with said body tissue portion.

2. An endoscopic surgical instrument as recited in  
3      claim 1, wherein said RF electrode means includes:  
4      a) a first RF electrode having a distal end and a  
5      proximal end, said first RF electrode being disposed  
6      within an insulating sheath;  
7      b) elongated guide means encasing said first RF  
8      electrode and said insulating sheath, for guiding said  
9      first RF electrode to a predetermined angle value from the  
10     longitudinal axis of said single access conduit;  
11     c) electrode movement mechanism means, attached to  
12     said proximal end of said first RF electrode, for moving  
13     said first RF electrode within said guide means, said  
14     distal end of said first RF electrode is extendable beyond  
15     an open end of said guide means up to a predetermined

15 length value and engagable with and insertable into said  
16 body tissue portion;

17 d) energy source means, in electrical communication  
18 with said proximal end of said first RF electrode, for  
19 transmitting energy into said distal end of said first RF  
20 electrode when it is extended beyond said guide means and  
21 into said body tissue portion to ablate said body tissue  
22 portion; and

23 e) tissue impedance measurement means, in electrical  
24 communication with said proximal end of said first RF  
25 electrode, for measuring an impedance associated with said  
26 body tissue portion engaged with said distal end of said  
27 first RF electrode when it is extended beyond said guide  
28 means.

1 3. An endoscopic surgical instrument as recited in  
2 claim 2 which further includes:

3 a) at least one other second RF electrode having a  
4 distal end and a proximal end, said second RF electrode  
5 being disposed within a second insulating sheath;

6 b) elongated second guide means encasing said second  
7 RF electrode and said second insulating sheath, for  
8 guiding said second RF electrode into a second  
9 predetermined angle value from the longitudinal axis of  
10 said single access conduit said second RF electrode  
11 separated from said first RF electrode by a predetermined  
12 width value;

13 c) said proximal end of said second RF electrode is  
14 attached to said electrode movement mechanism means, and  
15 said distal end of said second RF electrode is extendable  
16 beyond an open end of said second guide means up to a  
17 second predetermined length value so as to be engagable  
18 with and insertable into said body tissue portion;

19 d) said distal end of said second RF electrode is in  
20 electrical communication with said energy source means and  
21 said tissue impedance measurement means; and

22 e) whereby said electrode movement mechanism means  
23 moves each of said first RF and said second RF electrodes

24       within each of associated guide means, and said distal  
25       ends of each of said first RF electrode and said second RF  
26       electrode is extendable beyond and retractable within each  
27       of said associated guide means, and when each of said  
28       distal ends of each RF electrode is extended beyond said  
29       associated guide means said energy source means is  
30       energized to pass electrical current from one RF electrode  
31       to the other and said tissue impedance measurement means  
32       measures the impedance of tissue engaged between each of  
33       said distal ends of each RF electrode.

1       4. An endoscopic surgical instrument as recited in  
2       claim 3, wherein:

- 3       a) said predetermined angle value is greater than 0  
4       degrees and is less than 360 degrees;
- 5       b) said second predetermined angle value is greater  
6       than 0 degrees and is less than 360 degrees;
- 7       c) said predetermined length value is greater than 0  
8       cm and is less than 3 cm;
- 9       d) said second predetermined length value is greater  
10      than 0 cm and is less than 3 cm; and
- 11      e) said predetermined width value is greater than 0.1  
12      cm and is less than 2.0 cm.

1       5. An endoscopic surgical instrument as recited in  
2       claim 3, wherein:

- 3       a) said predetermined angle value is equal to said  
4       second predetermined angle value; and
- 5       b) said predetermined length value is equal to said  
6       second predetermined depth value.

1       6. A retractable RF electrode assembly for ablating  
2       and measuring the impedance of a body tissue portion,  
3       comprising:

- 4       a) a first RF electrode having a distal end and a  
5       proximal end, said first RF electrode being disposed  
6       within an insulating sheath;

7           b) elongated guide means encasing said first RF  
8           electrode and said insulating sheath, for guiding said  
9           first RF electrode into a predetermined angle value from  
10          the longitudinal axis of said single access conduit;

11          c) electrode movement mechanism means, attached to  
12          said proximal end of said first RF electrode, for moving  
13          said first RF electrode within said guide means, said  
14          distal end of said first RF electrode is extendable beyond  
15          an open end of said guide means up to a predetermined  
16          length value and engagable with and insertable into said  
17          body tissue portion;

18          d) energy source means, in electrical communication  
19          with said proximal end of said first RF electrode, for  
20          transmitting energy into said distal end of said first RF  
21          electrode when it is extended beyond said guide means and  
22          into said body tissue portion so as to ablate said body  
23          tissue portion; and

24          e) tissue impedance measurement means, in electrical  
25          communication with said proximal end of said first RF  
26          electrode, for measuring an impedance associated with said  
27          body tissue portion engaged with said distal end of said  
28          first RF electrode when it is extended beyond said guide  
29          means.

1           7. A retractable RF electrode assembly as recited in  
2           claim 6 which further includes:

3           a) at least one other second RF electrode having a  
4           distal end and a proximal end, said second RF electrode  
5           being disposed within a second insulating sheath;

6           b) elongated second guide means encasing said second  
7           RF electrode and said second insulating sheath, for  
8           guiding said second RF electrode into a second  
9           predetermined angle value from the longitudinal axis of  
10          said single access conduit, said second RF electrode  
11          separated from said first RF electrode by a predetermined  
12          width value;

13          c) said proximal end of said second RF electrode is  
14          attached to said electrode movement mechanism means, and

15        said distal end of said second RF electrode is extendable  
16        beyond an open end of said second guide means up to a  
17        second predetermined length value so as to be engagable  
18        with and insertable into said body tissue portion;

19        d)        said proximal end of said second RF electrode is in  
20        electrical communication with said energy source means and  
21        said tissue impedance measurement means; and

22        e)        whereby said electrode movement mechanism means  
23        moves each of said first RF and said second RF electrodes  
24        within each of associated guide means, and said distal  
25        ends of each of said first RF electrode and said second RF  
26        electrode is extendable beyond and retractable within each  
27        of said associated guide means, and when each of said  
28        distal ends of each RF electrode is extended beyond said  
29        associated guide means said energy source means is  
30        energized to pass electrical current from one RF electrode  
31        to the other and said tissue impedance measurement means  
32        measures the impedance of tissue engaged between each of  
33        said distal ends of each RF electrode.

1        8.        A retractable RF electrode assembly as recited in  
2        claim 7, wherein:

3        a)        said predetermined angle value is greater than 0  
4        degrees and is less than 360 degrees;

5        b)        said second predetermined angle value is greater  
6        than 0 degrees and is less than 360 degrees;

7        c)        said predetermined length value is greater than 0  
8        cm and is less than 3 cm;

9        d)        said second predetermined length value is greater  
10        than 0 cm and is less than 3 cm; and

11        e)        said predetermined width value is greater than 0.1  
12        cm and is less than 2.0 cm.

1        9.        A retractable RF electrode assembly as recited in  
2        claim 8, wherein:

3        a)        said predetermined angle value is equal to said  
4        second predetermined angle value; and

5                   b)    said predetermined length value is equal to said  
6                   second predetermined depth value.

1                   10.    An endoscopic surgical instrument as recited in  
2                   claim 2, further including:

3                   a)    means for bending said guide means to vary said  
4                   predetermined angle value.

1                   11.    An endoscopic surgical instrument as recited in  
2                   claim 10, wherein

3                   a)    said guide means includes a bendable bellows  
4                   portion disposed at a distal end of said guide means;

5                   b)    said bending means includes

6                   i)    a lever attached to said housing;

7                   ii)    a guide wire disposed within said guide means  
8                   and having a first end attached to said bellows portion of  
9                   said guide means; and

10                  c)    whereby actuating said lever tensions said guide  
11                  wire and varies said predetermined angle value.

1                   12.    An endoscopic surgical instrument as recited in  
2                   claim 3, further including:

3                   a)    means for bending each of said guide means for each  
4                   of said first RF electrode and said second RF electrode to  
5                   vary each of said predetermined and said second  
6                   predetermined angle values.

1                   13.    An endoscopic surgical instrument as recited in  
2                   claim 10, wherein

3                   a)    each of said guide means for each said first and  
4                   said second RF electrodes includes a bendable bellows  
5                   portion disposed at a distal end of each of said guide  
6                   means;

7                   b)    each of said bending means for each of said guide  
8                   means includes

9                   i)    a lever attached to said housing;

13                   c)    whereby actuating said lever tensions each of said  
14                   guide wires and varies each of said predetermined and said  
15                   second predetermined angle value.

1                   14. A retractable RF electrode assembly as recited in  
2                   claim 6, further including:

3                   a)   means for bending said guide means to vary said  
4                   predetermined angle value.

1           15. A retractable RF electrode assembly as recited in  
2           claim 14, wherein

3                   a) said guide means includes a bendable bellows  
4                   portion disposed at a distal end of said guide means;

5 b) said bending means includes

i) a lever attached to said housing;

10                   c)    whereby actuating said lever tensions said guide  
11                    wire and varies said predetermined angle value.

1           16. A retractable RF electrode assembly as recited in  
2           claim 7, further including:

3                   a)   means for bending each of said guide means for each  
4                   of said first RF electrode and said second RF electrode to  
5                   vary each of said predetermined and said second  
6                   predetermined angle values.

1           17. A retractable RF electrode assembly as recited in  
2           claim 16, wherein

3           a) each of said guide means for each said first and  
4            said second RF electrodes includes a bendable bellows  
5            portion disposed at a distal end of each of said guide  
6            means;

7           b)    each of said bending means for each of said guide  
8           means includes  
9            i)    a lever attached to said housing;  
10           ii)    a guide wire disposed within each of said  
11           guide means and having a first end attached to each said  
12           bellows portion of each of said guide means; and  
13           c)    whereby actuating said lever tensions each of said  
14           guide wires and varies each of said predetermined and said  
15           second predetermined angle value.

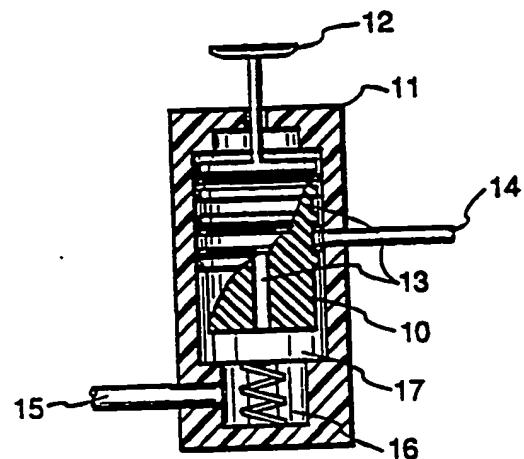


Fig. 1

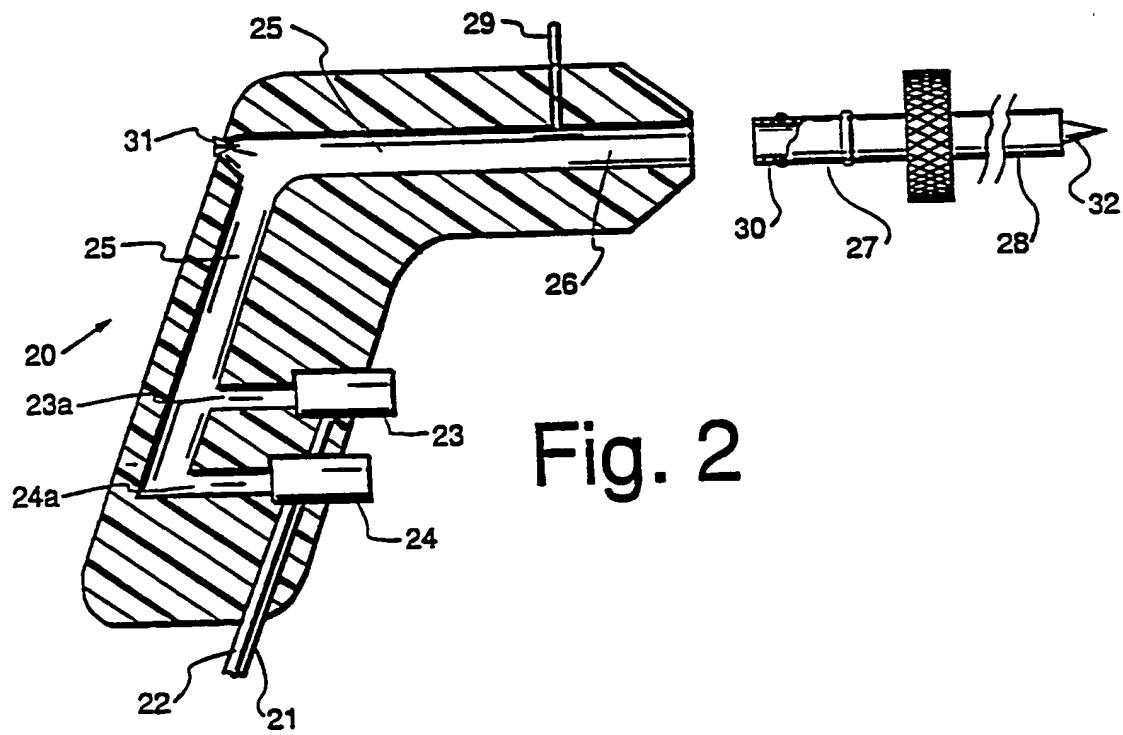


Fig. 2

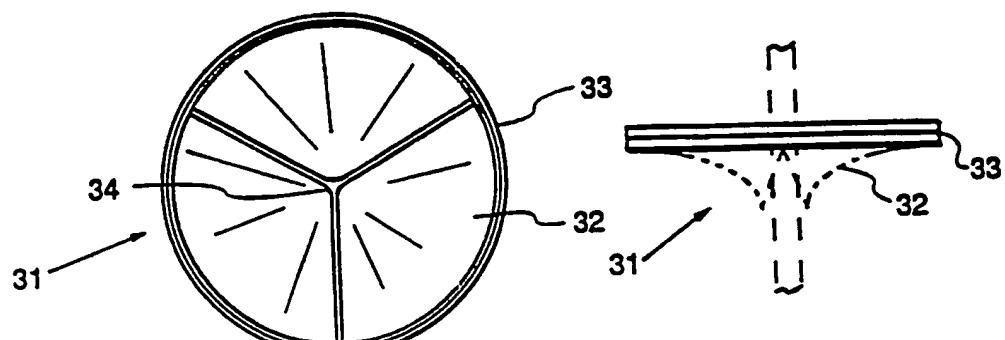


Fig. 3a

Fig. 3b

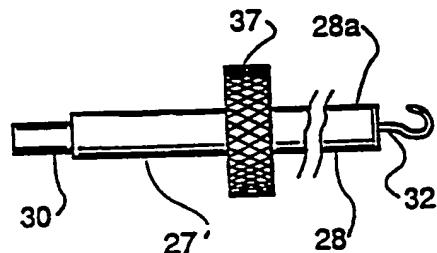
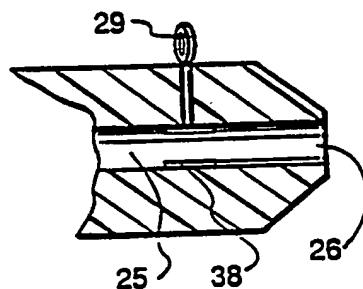


Fig. 4a

Fig. 4b

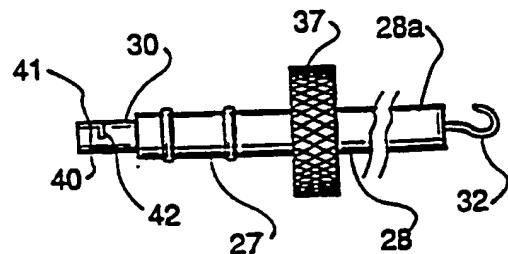
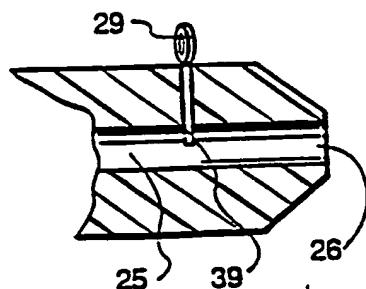


Fig. 5a

Fig. 5b

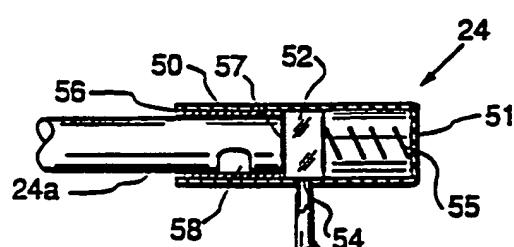


Fig. 7

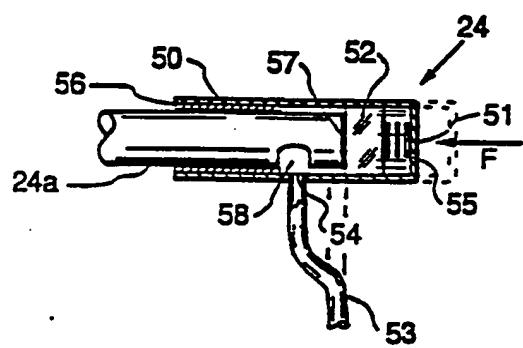


Fig. 8

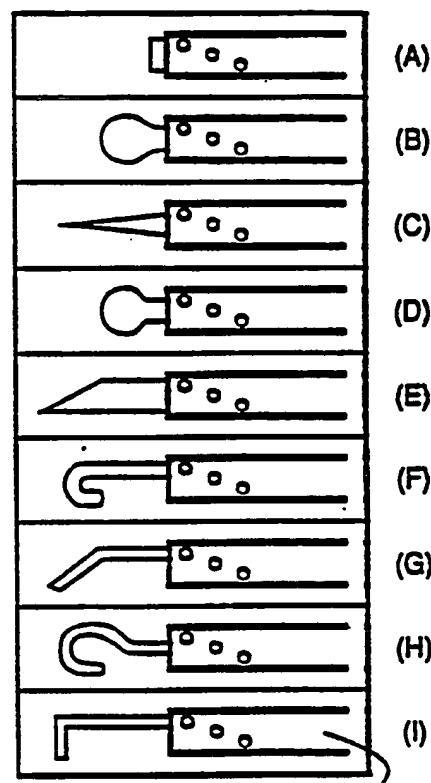


Fig. 6

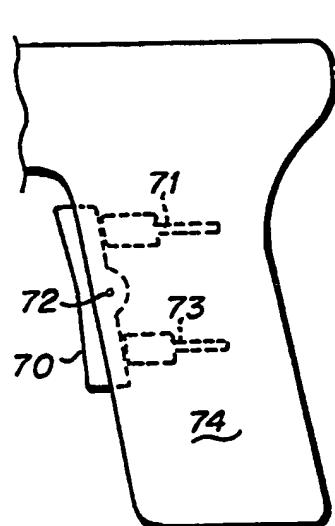
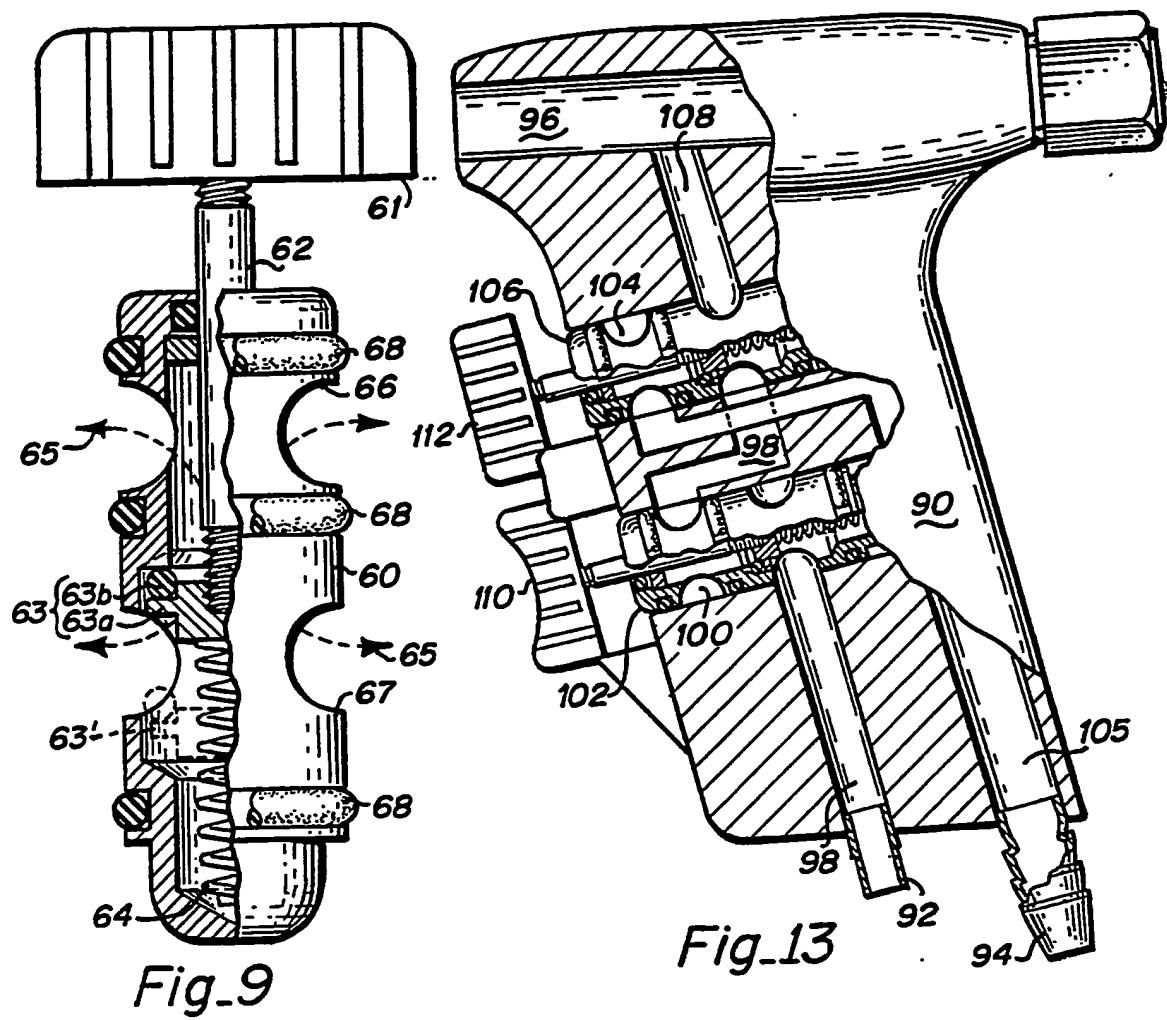


Fig. 10

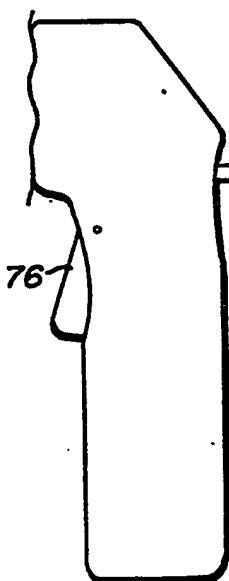


Fig. 11

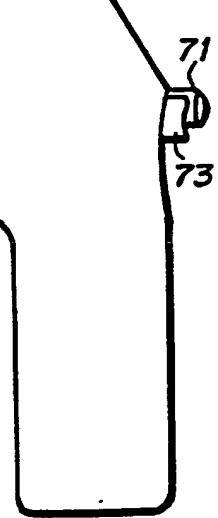
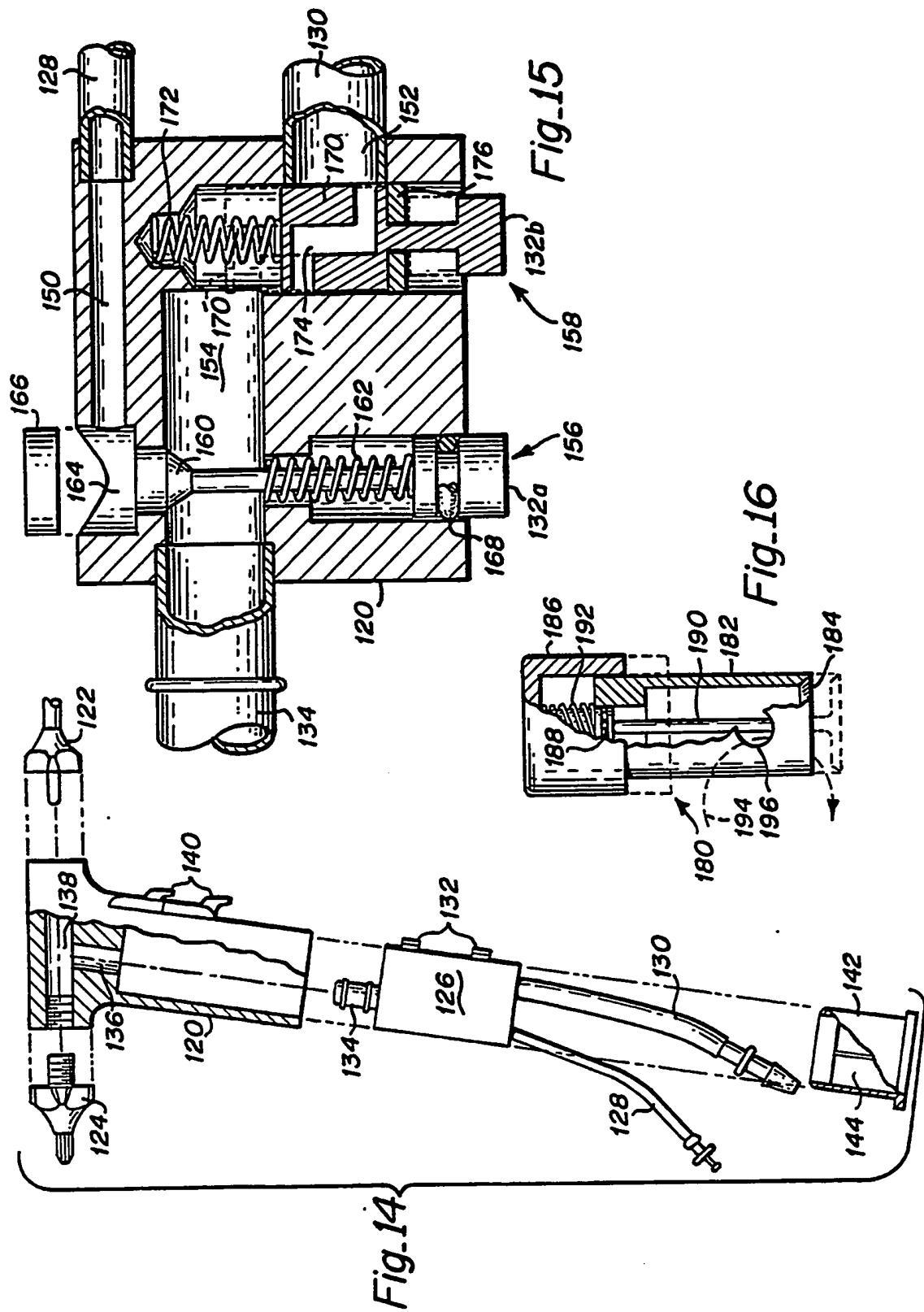
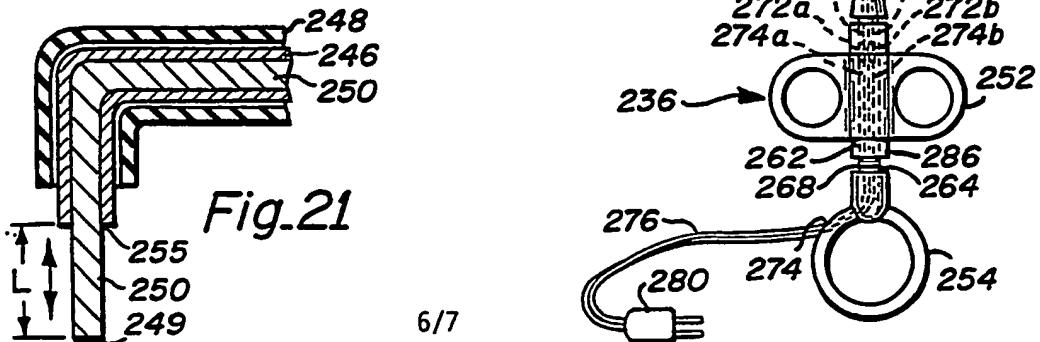
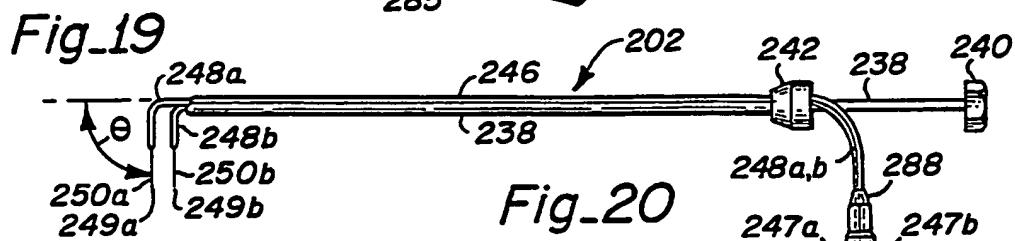
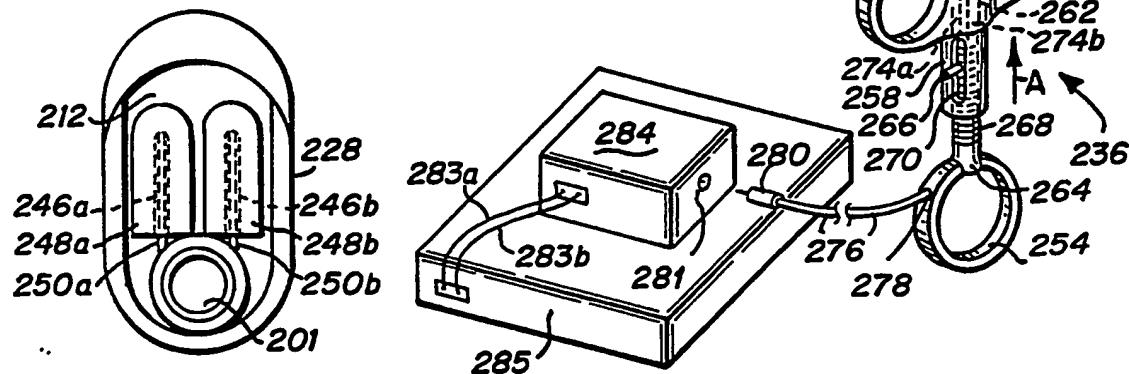
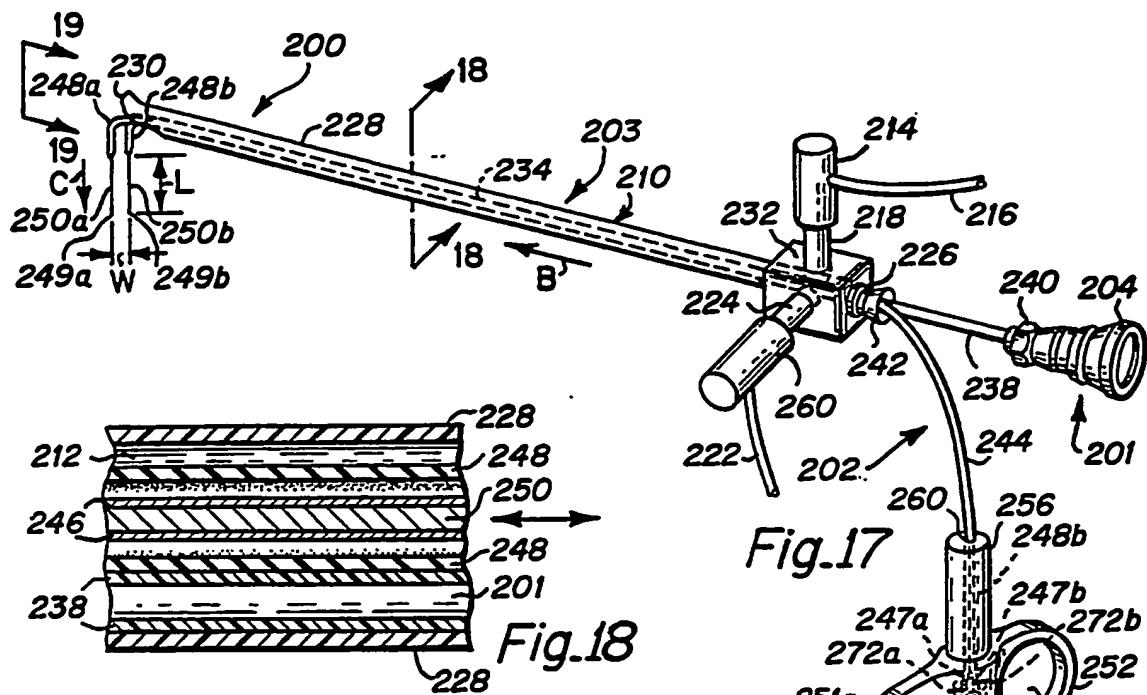
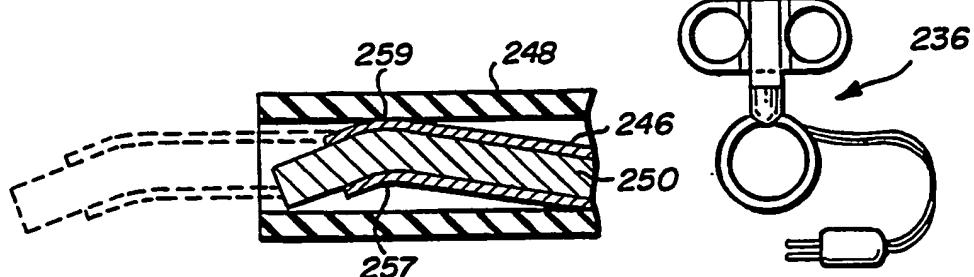
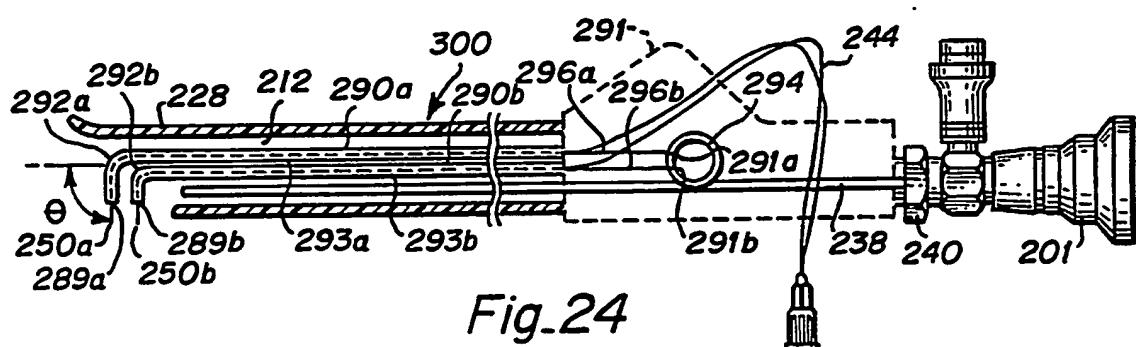
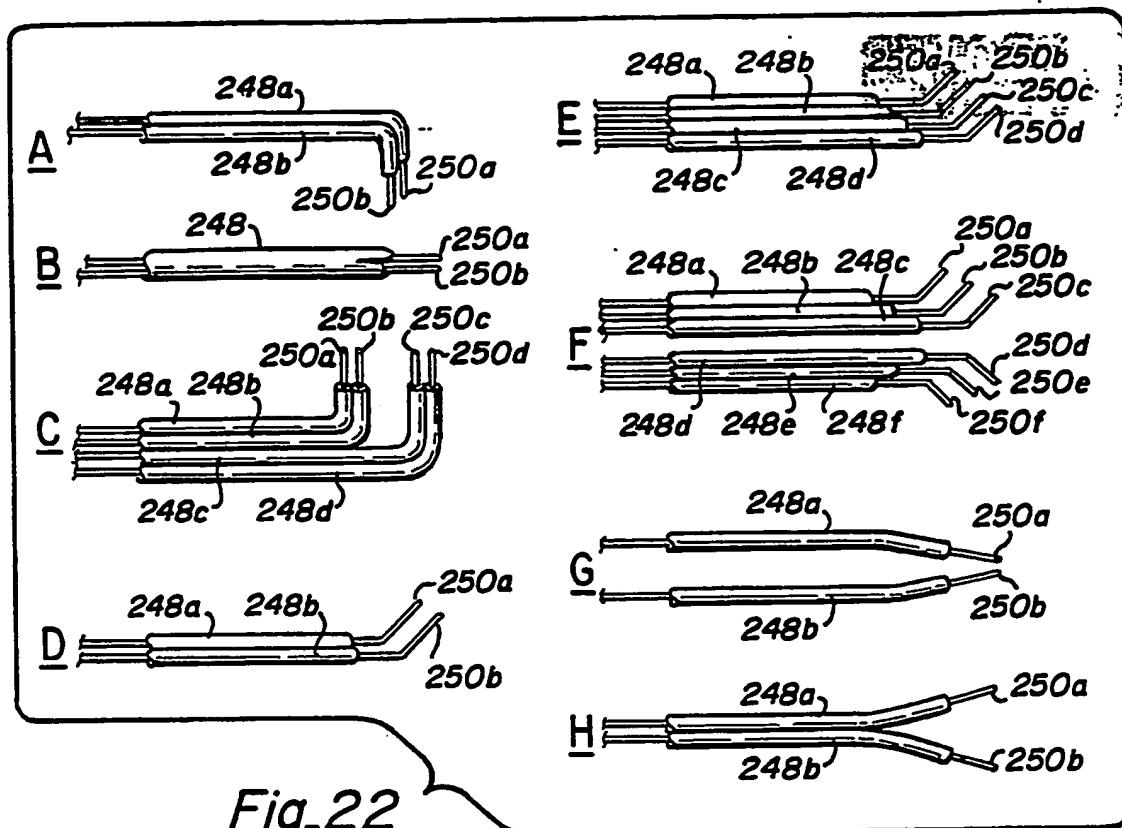


Fig. 12







## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US95/09152

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61F 5/48

US CL :128/885; 600/29; DIG.25

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 128/846, 885; 600/29; DIG. 25

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,195,958 (PHILLIPS) 23 March 1993, see the entire document.	1
Y	US, A, 4,565,200 (COSMAN) 21 January 1986, see the entire document.	1
A	US, A, 5,186,714 (BOUDREAU ET AL.) 16 February 1993, see the entire document.	2-17
A	US, A, 4,402,310 (KIMURA) 06 September 1983, see the entire document.	2-17

Further documents are listed in the continuation of Box C.

See patent family annex.

•	Special categories of cited documents:		
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier document published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reasons (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

10 OCTOBER 1995

Date of mailing of the international search report

26 OCT 1995

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